Claims:

1. A computer based method for determining the cavity size in packed bed systems using correlation or mathematical model, said method comprising the steps of:

   a) obtaining data related to material properties of the packed bed system;

   b) calculating the cavity radius for both increasing gas velocity and decreasing gas velocity using mathematical model incorporating the stresses/frictional forces as:

$$2nR^2 - 2nHR + \frac{pr\beta v_b^2 D_T^2}{2\pi^2 M}\left\{\ln\frac{W}{2\pi} - \ln(R - \frac{D_T}{2\pi}\right\} + \left(\frac{2r_o}{M\pi}\left(\alpha + \beta v_H\right)v_H\left(H - r_o\right) - \frac{F_{wd}}{M\pi}\right) = 0$$

(29) and

$$2nR^2 - 2nHR + \frac{pr\beta v_b^2 D_T^2}{2\pi^2 M}\left\{\ln\frac{W}{2\pi} - \ln(R - \frac{D_T}{2\pi}\right\} + \left(\frac{2r_o}{M\pi}\left(\alpha + \beta v_H\right)v_H\left(H - r_o\right) + \frac{F_{wd}}{M\pi}\right) = 0$$

(28)

   respectively; or calculating the cavity radius for both increasing gas velocity and decreasing gas velocity using mathematical equations based on correlation as:

$$\frac{D_r}{D_T} = 4.2\left(\frac{\rho_g v_b^2 D_T}{\rho_{eff}\ g\ d_{eff} W}\right)^{0.6}\left(\frac{D_T}{H}\right)^{-0.12}\left(\mu_w\right)^{-0.24} \qquad (36)$$

$$\frac{D_r}{D_T} = 164\left(\frac{\rho_g v_b^2 D_T^2}{\rho_{eff}\ g\ d_{eff} H\ W}\right)^{0.80}\left(\mu_w\right)^{-0.25} \qquad (33)$$

   respectively, and

   c) calculating the cavity size using the cavity radius obtained in step (b).

2. A method as claimed in claim 1, wherein the data related to material properties of the packed bed comprise bed height, tuyere opening, void fraction, wall-particle friction coefficient, inter-particle frictional coefficient, gas velocity, model width and particle shape factor.

3. A method as claimed in claim 1, wherein the data related to the material properties of the packed bed include experimental data already obtained or on-line data.

4. A method as claimed in claim 1, wherein the frictional force (F_{wd}) in equations 28 and 29 is given by:

$$F_{wd} = -\frac{4n\pi\mu_w K\, h\, pM}{3\left(1-\frac{\mu_W K}{n\pi}\right)}\left\{\left(r_o - \frac{D_T}{2\pi}\right)^3 - \left(R-\frac{D_T}{2\pi}\right)^3\right\} - 4pn\mu_w K \frac{\beta v_b^2 D_T^2}{4\pi\left(1+\frac{\mu_W K}{n\pi}\right)}\left(r_o - R\right)$$

$$+\frac{4n\pi\mu_w K\left(\frac{W}{2\pi}\right)^{1-\frac{\mu_w K}{n\pi}} h\, p\, M}{\left(1-\frac{\mu_w K}{n\pi}\right)\left(2+\frac{\mu_w K}{n\pi}\right)}\left\{\left(r_o-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_w K}{n\pi}} - \left(R-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_w K}{n\pi}}\right\} + 4pn\mu_w K\left(\frac{\beta v_b^2 D_T^2}{4\pi}\right)\times$$

$$\frac{1}{\left(\frac{W}{2\pi}\right)^{1+\frac{\mu_W K}{n\pi}}\left(1+\frac{\mu_w K}{n\pi}\right)\left(2+\frac{\mu_w K}{n\pi}\right)}\left\{\left(r_o-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_W K}{n\pi}} - \left(R-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_W K}{n\pi}}\right\} + \frac{2pW\alpha}{\left(2+\frac{\mu_w K}{n\pi}\right)}\left(\frac{W}{2\pi}\right)^{-\frac{\mu_W K}{n\pi}}\times$$

$$\left\{M - \frac{\alpha v_b D_T}{W} - \frac{\beta v_b^2 D_T^2}{W^2}\right\}\left\{1 - e^{-C\left(H-\frac{W+D_T}{2\pi}\right)}\right\}\left\{\left(r_o-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_W K}{n\pi}} - \left(R-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_W K}{n\pi}}\right\}+$$

$$W\left(\frac{W+D_T}{\pi}\right)\left\{M-\frac{\alpha v_b D_T}{W} - \frac{\beta v_b^2 D_T^2}{W^2}\right\}\left[\left(H-r_o\right)+\frac{\left\{e^{-C(H-r_o)}-1\right\}}{C}\right]$$

5. A method as claimed in claim 1, wherein to determine the cavity radius using increasing velocity correlation as given by equation 33 was developed using π-theorem to get the important dimensionless numbers

$$\frac{D_r}{D_T} = 164\left(\frac{\rho_g v_b^2 D_T^2}{\rho_{eff}\, g\, d_{eff} H W}\right)^{0.80}\left(\mu_w\right)^{-0.25}$$

where, symbols are Blast furnace radius W, Effective bed height H, Blast velocity v_b, Tuyere opening D_t, Void fraction ε, Gas viscosity μ_g, Particle size d_p, Shape factor ϕ_s, Density of gas ρ_g, Density of solid ρ_s, Coefficient of wall friction μ_w, acceleration due to gravity g, the effective diameter of the particle is given by $d_{eff} = d_p \phi_s$, effective density of the bed is given by $\rho_{eff} = \varepsilon\rho_g + (1-\varepsilon)\rho_s$, wall-particle frictional coefficient is given by $\mu_w = \tan\phi_w$, where, ϕ_w is an angle of friction between the wall and particle D_r is cavity diameter and all units are in SI.

6. A method as claimed in claim 1, wherein to determine the cavity radius using decreasing velocity correlation as given by equation 36 was developed using π-theorem to get the important dimensionless numbers

$$\frac{D_r}{D_T} = 4.2\left(\frac{\rho_g v_b^2 D_T}{\rho_{eff}\ g\ d_{eff} W}\right)^{0.6}\left(\frac{D_T}{H}\right)^{-0.12}(\mu_w)^{-0.24}$$

where, symbols are Blast furnace radius W, Effective bed height H, Blast velocity v_b, Tuyere opening D_t, Void fraction ε, Gas viscosity μ_g, Particle size d_p, Shape factor ϕ_s, Density of gas ρ_g, Density of solid ρ_s, Coefficient of wall friction μ_w, Acceleration due to gravity g, the effective diameter of the particle is given by $d_{eff} = d_p \phi_s$, effective density of the bed is given by $\rho_{eff} = \varepsilon\rho_g + (1-\varepsilon)\rho_s$, wall-particle frictional coefficient is given by $\mu_w = \tan\phi_w$, where, ϕ_w is an angle of friction between the wall and particle D_r is cavity diameter and all units are in SI.

7. A method as claimed in claim 1, wherein the packed bed systems include blast furnaces, cupola, corex, catalytic regenerator.